DYSCALCULIC CO-MORBIDITY IN SECONDARY SCHOOL GOING CHILDREN-A COMPREHENSIVE STUDY OF PREDICTING PARAMETERS AND REMEDIES

A
SYNOPSIS
SUBMITTED TO DAYALBAGH EDUCATIONAL INSTITUTE
(DEEMED UNIVERSITY), DAYALBAGH, AGRA
FOR THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR DEGREE OF
DOCTOR OF PHILOSOPHY IN EDUCATION
(2013-14)

SUPERVISOR
PROF. K. C. VASHISHTHA

INVESTIGATOR
NEHA GUPTA

HEAD
(DEPT. OF FOUNDATIONS OF EDUCATION)

DEAN
(FACULTY OF EDUCATION)

FACULTY OF EDUCATION
DAYALBAGH EDUCATIONAL INSTITUTE (DEEMED UNIVERSITY),
DAYALBAGH, AGRA – 5

1.0.0 INTRODUCTION

The term "learning disability" describes a neurobiological disorder in which a person's brain works differently. It emerged from a need to identify and serve the children who are apparently normal with no sign of any physical, mental and other disability. They often elude traditional categorization of exceptionality. The term “Learning Disability” was first coined by Samueal Kirk in 1963 to describe children who have serious learning problem in schools but do not fall under categories of handicap. These problems interfere with a person's ability to think and remember. Learning disabilities can affect a person's ability to speak, listen, read, write, spell, reason, recall, organize information, and do mathematics. Learning disorder is a classification including several disorders in which a child has difficulty learning in a typical manner, usually caused by an unknown factor which works as a disorder that affects the brain's ability to receive and process information. This disorder can make it problematic for a child to learn as quickly or in the same way as someone who isn't affected by a learning disability. A learning disability cannot be cured or fixed. With the support and intervention, however, child with learning disabilities can succeed in school and go on to be successful later in life. There are four types of learning disorders considered in children and they are -Dyscalculia, Dyslexia, Dysgraphia and Dyspraxia.

Today’s world requires us to process unprecedented levels of numerical information enabling us to comprehend number concepts and perform calculations. Computers, Smartphones, financial and health care information processing are just a few of the many contemporary demands requiring our numerical fluency. Mathematical skills are fundamental to independent living in a numerate society, affecting educational and employment opportunities and in turn, the socio-economic status. An understanding of how concepts of numeracy develop, and the manifestation of difficulties in the acquisition of such concepts and skills, is imperative. In today's high-tech, increasingly connected world, it is vital that young children build confidence in their ability to do mathematics, as deficiencies in this area can be a major impediment to many facets of life. Mathematical impairments have a negative influence on full-time employment in adulthood. Individuals display a mathematics disability when their performance on standardized calculation tests or on numerical reasoning tasks is comparatively low, given their age, education and intellectual reasoning ability (Diagnostic and Statistical Manual of Mental Disorder IV, 1994). Specific learning difficulty in mathematics is referred as ‘Dyscalculia’ or ‘number blindness’, in much the same way as dyslexia was once described as ‘word blindness’. It is the name given to the condition that affects our ability to acquire arithmetical skills.

The term Dyscalculia is derived from the Greek root ‘*dys*’ (difficulty) and Latin ‘*calculia*’ from the root word *calculus - a small stone or pebble used for calculation*. Essentially it describes a difficulty with numbers which can be a developmental, cognitive condition, or an acquired difficulty as a result of brain injury. Dyscalculia is defined as a specific learning disability affecting the

normal acquisition of arithmetic skills in spite of normal intelligence, emotional stability, scholastic opportunity, and motivation. According to Butterworth (2003) a range of descriptive terms have been used, such as 'Developmental Dyscalculia', 'Mathematical Disability', 'Arithmetic Learning Disability', 'Number Fact Disorder' and 'Psychological Difficulties in Mathematics'.

Dyscalculia is a math-related learning disability. The first neuropsychological definition of dyscalculia was put forward by the researcher Kosc (1974), who defined it as a difficulty in mathematical performance resulting from impairment to those parts of the brain that are involved in mathematical processing, without a concurrent impairment in general mental function. This definition is the same definition that researchers in cognitive neuroscience use today when searching for the causes and features of dyscalculia.The National Numeracy Strategy (Department for Education and Skills, USA, 2001) defined Dyscalculia as: '*Dyscalculia is a condition that affects the ability to acquire arithmetical skills. Dyscalculic learners may have difficulty in understanding simple number concepts, lack an intuitive grasp of numbers, and have problems learning number facts and procedures. Even if they produce a correct answer or use a correct method, they may do so mechanically and without confidence.*' Stanislas Dehaene and Butterworth (2009) defined *Dyscalculia as a more fundamental inability to conceptualize numbers as abstract concepts of comparative quantities* (a deficit in number sense), which these researchers consider to be a foundational skill, upon which other math abilities build. Respected experts in this field such as Butterworth, Sharma, Miles and Chinn suggest that the nature of dyscalculia rests with the inability to see, handle and understand numbers. The inability occurs at the concrete level but especially at the abstract level.

1.1.0 PREVALENCE RATE OF DYSCALCULIA

Until recently, Dyscalculia was considered to be a relatively rare learning disability with a prevalence of one percent, significantly less than other learning disabilities or Attention-Deficit Hyperactivity-Disorder(ADHD). In the past decade, research on the epidemiology of Dyscalculia conducted over the globe has been based on basic research principles. The results of these studies have changed the notion that Dyscalculia is a rare disorder and today the evidence shows that the prevalence of Dyscalculia is no less than that of Dyslexia, ranging from 3-14percent. Dyscalculia prevalence studies have been performed in many countries using different criteria (Jovanovic et al., 2008). There is a general agreement that around 5-8 percent of pupils suffer from Dyscalculia (Geary, 2004). On average, each class of 30 children will have approximately two or three pupils who are affected by it (Hannell, 2005). According to studies done by Lewis, Hitch and Walker in 1994, 1.3 percent are dyscalculic while 2.3percent are Dyscalculic and Dyslexic both - that means about 3.6percent of the World's population are Dyscalculic. That gives a total of between 3.6 and 6.5percent of the World's population.

Research by Desoete et al. (2004) investigated the prevalence of dyscalculia in children. Results indicated that of 1, 336 pupils in III class, prevalence was 7.2 percent (boys) and 8.3 percent (girls), and of 1, 319 IV grade pupils, 6.9 percent of boys and 6.2 percent of girls. Koumoula et al. (2004) tested a sample population of 240 children in Greece using the Neuropsychological Test Battery for Number Processing and Calculation in Children, and a score of <1.5 SD was identified in 6.3 percent of the sample. Mazzocco and Myers (2003) used multiple tests of arithmetic skills together with a criterion of persistent diagnosis and depicted rates for III grade children fell between 5 percent and to 21 percent.

Prevalence rate at National Level is reported by various researchers. Ramaa S. et al., (2002) reported 5.54-5.98 percent of Dyscalculic students of primary level, Vijayalaxmi (2009) quoted 10.48 percent of Dyscalculic and 15.17 percent Co-morbid students in Belgaum city. Prevalence of Dyscalculia was found to be 1.58 percent in Chandigarh by Chavan et al., (2011) at school age. Mogasale and Patil (2012) found 10.5 percent Dyscalculic students of age group 8-11 in Southern part of India. Prevalence rate of Dyscalculia according to various studies referred in tabular presentation given here.

Table 1.1: Exhibiting the Prevalence Rate of Dyscalculia As Reported by Researcher

S.N	Year	Study	Prevalence Rate (In Percentage)	Population (Age Group)
1	2001	Shalev et al.	3-6	10-12
2	2001	Teresa Guillemot	3-6	Primary School
3	2002	Fuchs &Fuchs	6-7	Class 4th.
4	2003	Munro	3-6.5	School age
5	2004	Pandit	9	Grade V
6	2004	Shalev	5-6	School age
7	2005	Dowker	5-8	School age
8	2005	Monuteaux et al.	3-6	School age
9	2006	Behrad	5.2	Class I- V
10	2007	Shalev& Aster	3.5-6.5	School age
11	2008	Shalev and Aster	3-14	Primary Class
12	2009	Desoete	3-14	School age
13	2009	Geary et al.	7	Primary Class
14	2010	Rubinsten and Tannock	3.5- 6.5	School age
15	2010	Gowramma et al.	1	School age
16	2011	Tajar&Sharifi	3-6	SixYears
17	2011	Emmanuel & Elizabeth	3-8	School age
18	2012	Kaufmann and Aster	5	Primary Schools
19	2013	Jovanovic et al.	9.9	9-10(3rd class)

It is clear from the above mentioned figures that Dyscalculia has prevalence rate of 3-6 percent at National as well as International Level.

1.2.0 SYMPTOMS OF DYSCALCULICS

Dyscalculia is not synonymous with all forms of arithmetic and mathematical difficulties. Dyscalculia is characterized by severe arithmetic difficulties and accounts for only a subset of individuals with arithmetic difficulties. It seems that no dyscalculic has problems with math alone, but also struggle with problems being able to learn to tell time, left/right orientation, rules in games and much more. In Dyscalculia, as mentioned in *Diagnostic and Statistical Manual of Mental Disorder, IV (DSM IV, 1994),*the learning problem is specific to the domain of arithmetic (reading and spelling skills are within the normal range); manifests partly as problems in learning and remembering simple arithmetic facts (such as single-digit sums or products; e.g., 3+4 = 7), rather than more general problems in computation; typically defined by very low scores on standardized tests of arithmetic achievement, e.g., below the 8^{th} or even 5^{th} percentile, which is equivalent to standard scores below 78 and reflects a specific impairment in brain function that gives rise to unexpected problems in basic numerical processing, such as automatic or implicit processing of quantities or numbers.

Research also indicates that Working Memory difficulties are implicated in specific Mathematics difficulties like Geary (1993) suggests that poor working memory resources affect execution of calculation procedures and learning arithmetical facts. Mabbott and Bisanz (2008) claim that children with identifiable Mathematics learning disabilities are distinguished by poor mastery of number facts, fluency in calculating and working memory, together with a slower ability to use 'backup procedures', concluding that overall dyscalculia may be a function of difficulties in computational skills and working memory. However it should be pointed out that this has not been replicated across all studies (Temple and Sherwood, 2002).Research by Hanich et al. (2001) and Jordan et al. (2003) claim that children with mathematical difficulties appear to lack an internal number line and are less skilled at estimating magnitude. Wilson et al. (2006) suggest that assessment of developmental symptoms should examine number sense impairment. This would includes reduced understanding of the meaning of numbers, and a low performance on tasks which depend highly on number sense, including non symbolic tasks (e.g. comparison, estimation or approximate addition of dot arrays), as well as symbolic numerical comparison and approximation.

Trott (2009) suggests some mathematical difficulties which are also experienced by dyslexic students in higher education. These are;

(i) *Arithmetical problems* in place value and moving from concrete to abstract.
(ii) *Visual perceptual problems* in reversals and substitutions e.g. 3/E or +/x, problems copying from a sheet, board, calculator or screen, losing the place in multi-step calculations, substituting names that begin with the same letter, e.g. integer/integral, diagram/diameter.

(iii) *Short Term Memory problems* in forgetting names, dates, times, phone numbers.
(iv) *Reading problems* like slow reading speed, compared with peer.
(v) *Writing problems*, scruffy presentation of work, poor positioning on the page.
(vi) *General problems*, fluctuations in concentration and ability, increased stress or fatigue.

Thus general symptoms that may be addressed in Dyscalculic students are represented in following figure:

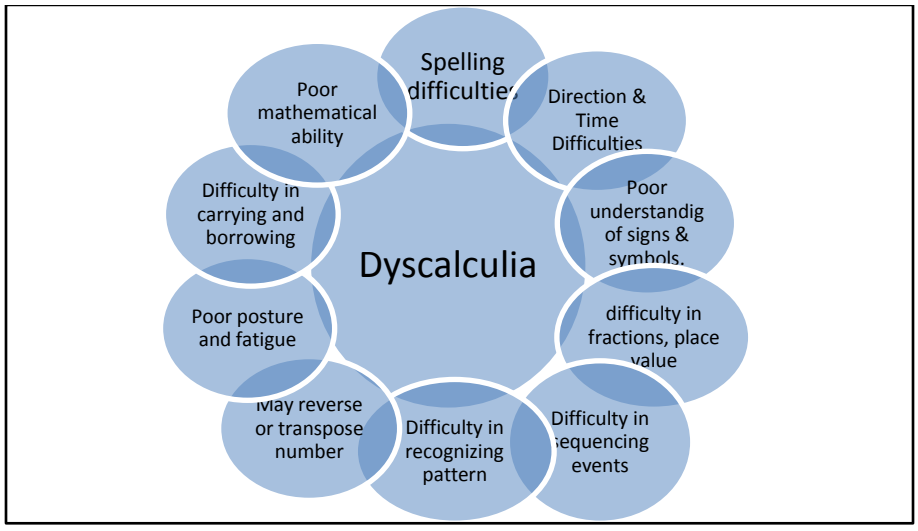

Fig. 1.1 Exhibiting the General Characteristics of Dyscalculia
Source: Extracted from the Referred Researches in Text

1.3.0 TYPES OF DYSCALCULIA

Dyscalculia can be *quantitative*, which is a deficit in counting and calculating or *qualitative*, which is a difficulty in the conceptualizing of math processes. Dyscalculia found in students in different domains and areas. It is classified in number of ways. *Zainab and Sasikumar*(2013) define two subtypes of mathematics disorder: (i) *Mathematical Computation Disorder* which affects an individual's ability to solve math calculations i.e. difficulty in completing simple addition, subtraction, multiplication, and division problems. (ii) *Mathematical Reasoning Disorder* which affects an individual's ability to utilize mathematical reasoning to solve problems i.e. difficulty in abstract concepts of time and direction.

Geary (2004) describes three sub types of dyscalculia: procedural, semantic memory and visuo-spatial. The *Procedural Subtype* is identified where the individual exhibits developmentally immature procedures, frequent errors in the execution of procedures, poor understanding of the concepts underlying procedural use, and difficulties sequencing multiple steps in complex procedures. This type has evidence of left hemisphere pre-frontal brain dysfunction, that can be ameliorated or improve with age. *The Semantic memory Subtype* is identified where the individual

exhibits difficulties in retrieving mathematical facts together with a high error rate. Dysfunction appears to be located in the left hemisphere posterior region, is heritable, and is resistant to remediation. The *Visuo spatial Subtype* represents a difficulty with spatially representing numerical and other forms of mathematical information and relationships. Brain differences appear to be located in the right hemisphere posterior region.

In a landmark article, Kosc (1974) identified six types of Dyscalculia. These types are:

(i) *Verbal dyscalculia,*a difficulty in using mathematical concepts in oral language.
(ii) *Practognostic dyscalculia,*difficulty in manipulating concrete materials.
(iii) *Lexical dyscalculia,*a difficulty in reading mathematics symbols.
(iv) *Graphical dyscalculia,*a difficulty in writing mathematics symbols.
(v) *Ideognostic dyscalculia,* a difficulty in understanding mathematical relationships.
(vi) *Operational dyscalculia,*a difficulty in performing specified mathematical operations.

*Guillemot (2001)*quoted three types of Dyscalculia in reference of Kosc, (1974), Shalev & Gross-Tsur, (1993, 2001).

(i) *Developmental dyscalculia,* originates from a specific impairment in the brain function.
(ii) *Acalculia,* where a person has lost all sense of meaning of numbers.
(iii) *Pseudo-dyscalculia* which based on emotional blockage or a confidence problem.

1.4.0 POTENTIAL PREDICTORS OF DYSCALCULIA

Dyscalculia is a specific learning disability affecting the normal acquisition of arithmetic skills. Genetic, neuro-biologic, and epidemiologic evidence indicates that dyscalculia, like other learning disabilities, is a brain-based disorder. However, poor teaching and environmental deprivation have also been implicated in its etiology. Because the neural network of both hemispheres comprises the substrate of normal arithmetic skills, dyscalculia can result from dysfunction of either hemisphere, although the left parietotemporal area is of particular significance. Dyscalculia can occur as a consequence of prematurity and low birth weight and is frequently encountered in a variety of neurologic disorders, such as Attention-Deficit Hyperactivity Disorder (ADHD), developmental language disorder, epilepsy, and fragile X syndrome.

Dyscalculia (Mathematics underachievement) can be due to a range of causes. Munro (2003) mentioned lack of motivation or interest in learning mathematics, low self efficacy, high anxiety, inappropriate earlier teaching or poor school attendance. It can also be due to generalized poor learning capacity, immature general ability, severe language and reading disorder or sensory processing. Some aspects of both literacy and arithmetic learning draw on the same cognitive processes. For example, both demand the ability to learn and use alphanumeric symbols and to retain these in the memory. It is possible that the processes involved in learning letter clusters are those also used to learn arithmetic symbolism (Geary, 2001). Pandit (2004) enlisted self-study habits of students, Socio-economic status of parents, Parental Behavior, Family Size, Location of

school and quality of instructions as major factors affecting learning disability in mathematics. There may also be causes from different domains which affects Dyscalculic students like neurological, Deficits in Working Memory and Short Term Memory (Tajar & Sharifi, 2011). Shalev (2004& 2001) quoted Environmental Deprivation, Poor teaching, Classroom Diversity, Over-crowded classrooms, Differential treatment towards girls, Untested Curricula, Mathematical Anxiety and Neurologic Deficits as predictors of Dyscalculia. Common conditions causing or impacting on Dyscalculia include ADHD (Lindsay, Tomazic, Levine & Accardo, 2001) Deprivation and Anxiety (Aster & Shalev, 2007). Apart from all these factors, language difficulties also code for Dyscalculia (Dowker, 2004).

1.5.0 DYSCALCULIC CO-MORBIDITY

Co-morbidity refers to the co-occurrence of one or more diseases or disorders in an individual. The co-occurrence has been termed *'homotypic'* co-morbidity, meaning co-morbidity between different members of a general class of disabilities (e.g., reading and mathematical disabilities are both developmental disabilities). *'Heterotypic'* co-morbidity is used for the condition where the two disabilities are part of different classes of disabilities, for example mathematical disabilities and depression (Arcelus &Vostanis, 2005). Another distinction is made between *'concurrent'* and '*successive'* co-morbidity. *Concurrent co-morbidity* is that in which two or more disabilities are present at the same time, such as reading and mathematical disabilities. *Successive co-morbidity* is defined as co-morbidity in which disabilities may occur at different times in a person's life, in ways that may or may not be causally related to each other, such as developmental language disorders and learning disabilities (Hall, Lynskey, & Teesson, 2001). Different methods to assess co-morbidity make study outcomes often difficult to compare. Prevalence of different disabilities that were reported in co-morbidity with mathematical disabilities are concurrent homotypic co-morbidity of mathematical disabilities and reading disabilities which vary from 17 percent (Gross-Tsur *et al.*, 1996) to 43 percent (Badian, 1983). Shalev, Manor, & Gross-Tsur (1997) found that children with mathematical disabilities in combination with reading disabilities were more profoundly impaired than children with mathematical disabilities alone. A second concurrent homotypic co-morbidity that is often reported in children with mathematical disabilities is a writing disability. The co-morbidity of mathematical and writing disabilities is about 50 percent (Ostad, 1998; Shalev & Gross-Tsur, 2001). In addition, the chronicity of the mathematical disability is found to be associated with co-morbid writing problems (Shalev, Manor & Gross- Tsur, 2005). Furthermore, studies revealed children with visuo-spatial learning disabilities to have concurrent problems to write number numbers down and to borrow and carry over in subtractions (Forrest, 2004). A successive co-morbidity is found in early language disorders. Many children with mathematical

learning disabilities appeared to have Developmental Language Disorders (DLD) at preschool age (Scheiris & Desoete, 2008).

Several models evolved out of an attempt to understand co-morbidity within an individual (Neale & Kendler, 1995; Pennington, 2006; Rhee, Hewitt, Corley, Willcutt, & Pennington, 2005). Some of them are: *the cognitive subtype hypothesis, the severity hypothesis and the three independent disorders model.* The 'cognitive subtype hypothesis' expects the group with co-morbid disabilities to have more severe deficits (both quantitative and qualitative) than the group with isolated disabilities (Kibby, Marks, Morgan, & Long, 2004). The severity hypothesis predicts that the problems of the co-morbid group are more severe than the problems of the isolated groups (Pennington, 2006). The three independent disorders model (Van der Sluis et al., 2004) predicts that problems of the co-morbid group are an additive combination of the problems of the isolated groups.

Reading disabilities and mathematical disabilities co-occur more frequently than would be expected by chance, sampling bias, population stratification, definitional overlap and later biases (Desoete, 2008). The co-morbidity rate of combined mathematical and reading disabilities (M+RD) varies from 17 percent to 43 percent (Fuchs & Fuchs, 2002; Light & deFries, 1995). Also in adults, co-morbidity remains an important topic (Clark, Watson, & Reynolds, 1995; Pennington, 2006). Nevertheless only a limited number of studies focus on co-morbidity in students and adults. Martinez et al., (2004) revealed that students with Mathematical and Reading difficulty had more problems at schools and were more often depressive than students without learning disabilities. In addition to this, Price and Ansari (2013) suggested that Dyscalculia often co-occurs (co-morbid) with other learning difficulties such as Dyslexia and Attention-Deficit Hyperactivity-Disorder (ADHD). Lindsay, Tomazic & Accardo (1999) quoted that some overlap between dyscalculia and dyslexia occurs. 6.4 percent of students aged 6 to 14 years had Dyscalculia, 3.7 percent of whom had delayed skills in mathematics alone while 2.7 percent had delayed skills in both reading and Mathematics. Munro (2003) quoted the findings of Levin, Goldstein and Spiers (1997) that some individuals can read words but not numbers while others show Dyscalculia as a result of more general spatial processing difficulties.

Researches in the United States (Badian, 1983), Norway (Ostad, 1998), Israel (Gross-Tsur, Manor, & Shalev,1996), and Europe (Kosc,1974) have shown that 5 percent to 8 percent of school-age children exhibit some form of mathematical disabilities (MD) and associated long-term problems (Geary, 2004; Griffin & Case,1997). With many of these students, reading disabilities (RD) and ADHD have been identified as co-morbid disorders (Geary, 2004; Gross-Tsur et al., 1996). Fletcher and Loveland (1986) found that 81 percent of the children with learning disabilities had problems with mathematics and reading, whereas 18 percent only had Mathematical problems ('pure MD'

group) and 1 percent failed only in reading tasks. Kaufmann and Aster (2008) found 20 percent to 60 percent affected form co-morbid disorders such as Dyslexia or Attention deficit disorder. Thus, Dyscalculia may or may not be present in independent form. It is often found with other Learning disabilities of same or different classes. Dyslexia is primarily associated with Dyscalculia and hence require remedial of Dyslexia as well as Dyscalculia.

2.0.0 DYSCALCULIC CO-MORBIDITY AND ENVIRONMENTAL DEPRIVATION

'Deprivation' refers to unmet need due to a lack of resources, so when referring to 'environmental deprivation', it means the absence of physical environmental conditions that can contribute to good physical and mental health and well being. It is lack of environmental resources that can contribute to a person's health and wellbeing i.e. presence of poor environmental determinants and absence of good environmental determinants.

Glen (1969) mentioned that a child is environmentally deprived to the extent that he has not developed his intellectual ability and a positive self-image. Environmental deprivation is often caused by a limited quantity and poor quality of interaction between a child and adults, particularly his parents. The quality and the amount of interaction are reduced by conditions prevalent in poor homes: (i) *parents' low educational achievement, (ii) absence of the father in the home, (iii) a large family, (iv) a crowded home, (v) a high rate of physical and mental illness, and (vi) a parental attitude of psychological defeat.* All of these factors contribute to limited intellectual development and a negative self-concept. Because schools are oriented to the American society, they fail to respond to the life style, values, and culture of minority group children. The family environment has been identified as a key factor that can provide both risks (e.g., discord, inconsistent discipline) and protection (e.g., a supportive adult relationship, cohesive family functioning) for the developing child. Problems with information processing may be evident at home as well as at school; thus, parents may experience different types of interactions with their children who have learning disabilities than with their children who do not have learning disabilities. Parental expectations and disappointment with a Dyscalculia child's poor academic performance also increase family stress (Kaslow and Cooper, 1978).

Olden & Guthrie (2001) found compelling evidence that environmental agents can cause life-long learning disability. The environment seldom operates in isolation; many other factors must be in place for a particular exposure to cause the specific damage needed for learning deficits to develop. Khokhar and Upadhayay (2007) concluded that deprived physical environment and uncomfortable living facilities adversely affect students learning process and adjective behavior. It also hampers the physical and mental growth of students. Physical environment deprived adolescent lacks in energy

and mental stability. They generally find themselves unfit in performing typical physical and mental tasks. Since Mathematics is a subject which requires crucial mental set-up, thus environmental deprivation affects performance of students. As supported by Troulli et al. (1992), the factors that affect the performance of pupils in school lessons, particularly in mathematics could be classified into two broad categories: *intrinsic or individual* factors which are associated with specific characteristics and *external or environmental factors* that are associated with the pupil's family, school and the wider cultural environment. These factors are very important and can cause disturbances in pupil's learning or even lead to a high percentage of pupils in under-performing or general failure in Mathematics (Henderson et al., 2003). Recent studies have shown that the attitude of people to children and adolescent living in deprived physical environment effect their self-respect, self-concept and self evolution (Jain, 2003).

Environmental causes are hard to pinpoint, although it appears that children from ghetto areas tend to exhibit more learning problems. Poor quality of teaching can be another environmental factor contributing to academic difficulties (Hallahan & Kauffman, 1994). Supporting this argument Lovitt (1978) quotes "a condition that might contribute to a learning disability is poor instruction. Although many children are able to learn in spite of poor teachers and inadequate techniques, others are less fortunate. Some youngsters who have experienced poor instruction in the early grades never catch up with their peers."Desforges (2003) reported that parental involvement in the form of 'at-home good parenting' has a significant positive effect on children's achievement and adjustment. According to McLoughlin (1985) environmental factors might be involved in the case of learning disabilities. Poor nutrition, health, and safety can precipitate these problems; as can inadequate linguistic and cognitive models in the home. Further, he pointed out that socio-cultural factors that do not reinforce values for education, regular school attendance, work and study habits, and other supportive skills may create more difficulty for the LD Person.

Gifford (2005) pointed out that academic performance may reflect factors such as children's lack of early number learning experience. Pre-schoolers' number learning is significantly affected by the socio-economic status of families and home learning environment (Sammons et al., 2002). Shalev (2004) supported that the etiology of developmental dyscalculia is most probably multifactorial, including genetic predisposition, environmental deprivation, poor teaching, classroom diversity, untested curricula, mathematical anxiety, and neurologic deficits. Pandit (2004) revealed that the factors related to the children with learning disabilities in mathematics were the poor instruction, parents' adverse behavior to them, teacher's negligence in the class, self study habits, socio-economic status, family size, school location**.** It was suggested that the quality of teaching strategies and quality of instruction in the schools must be improved.

3.0.0 DYSCALCULIC CO-MORBIDITY AND SELF-ESTEEM

Self-esteem in simple words refers to the feeling which comes from way in which we see and think about ourselves the awareness of what is good and having done it. It is defined as appreciating one's own worth and importance and having the characteristics to be accountable for one-self and to act responsibly towards other. Self-esteem is defined by Woolfolk (2005) as *an affective act and encapsulates the value or worth we attach to our self-assessments*. Self-esteem is widely acknowledged as being less malleable than self-concept as it encompasses the ways that individuals feel about their strengths and weaknesses. Scott (1996) quoted that Self-esteem is construed as those aspects or attitude that are classified as self evaluative. Self-esteem helps in building optimistic attitudes, willingness to accept responsibility, improves performance and makes a person self motivated. Self-esteem is how we value ourselves; it is how we perceive our value to the world and how valuable we think we are to others. Self-esteem affects our trust in others, our relationships, our work – nearly every part of our lives. Positive self-esteem gives us the strength and flexibility to take charge of our lives and grow from our mistakes without the fear of rejection.

Aoife (2011) contends that Dyscalculic children who have learning disabilities are at risk for having lower self-esteem and self worth than that of their peers. Low self-esteem is a debilitating condition that keeps individuals from realizing their full potential. It includes negative view of life, mistrusting others even those who show signs of affection, blaming behavior, feelings of being unloved and unlovable and fear of being ridiculed. Mann, Hosman, Schaalma, and De Vries (2004) affirm that self-esteem is analogous to self-regard, self-worth, and self-estimation. Research (Emmanuel and Elizabeth, 2011) supports a relationship between expressed low self-esteem and the learning experience of Dyscalculic students with learning disabilities. Hamid (2013)examined the co-relation of mathematics anxiety, self-esteem, proactive coping, and test stress with mathematics achievement among 8-10 year Brunei secondary school students. Dyscalculic students with learning disabilities often experience low levels of self-esteem, perhaps with negative effect on their academic success. Understanding the relationship between self-esteem and the learning outcomes of Dyscalculic students with learning disabilities may assist rehabilitation counsellors to develop interventions more effective at enhancing self-esteem, which should result in enhanced academic success outcomes for this group (Wehmeyer, 1996).

Many students expressing Dyscalculia with learning disabilities display low frustration tolerance, a tendency to become bored very easily or often, a lack of motivation for all but the most stimulating activities, and a relative inability to recognize future consequences of behavior or to learn from mistakes. This development is as a result of their inability to experience success in the classroom. Based on this therefore, they perceive themselves as academic failures and as such, often develop a

syndrome that includes a variety of self-defeating motives. For example, these students are far more apt to develop low levels of self-efficacy, low motivation, make negative self-statements, experience hopelessness and helplessness, resulting in poor academic performance. A relationship between self-esteem and students' future academic and career aspirations has been suggested (Chiu, 1990). Munro (2003) reported that students with Dyscalculia may have low self efficacy and selective attentional difficulties. Mathematics underachievement can be due to a range of causes, for example, lack of motivation or interest in learning mathematics, high anxiety and inappropriate earlier teaching or poor school attendance. It can also be due to generalized poor learning capacity, immature general ability, severe language disorders or sensory processing. Rubinsten and Tannock (2010) concluded that mathematics anxiety is closely associated with Dyscalculia. Personal causes of Mathematics anxiety include low self-esteem, lack of confidence and the influence of previous negative experiences with mathematics. Thus, students with both co-morbid Dyscalculia exhibits more severe attentional and emotional difficulties impairments than do those without learning disabilities in both areas.

4.0.0 DYSCALCULIC CO-MORBIDITY AND PEER INVOLVEMENT

The importance of peers in the lives of students living in Western cultures has been well documented (Greenberger, Chen, Tally, & Dong, 2000). Harris (2002) maintained that peer groups have an even stronger influence than that of parents, although that extreme position has been refuted by other researchers (Berk, 2005). Zitzmann (2005) found concurrent association between peer relationship and academic performance. Stewart (2007) found that individual-level predictors, such as student’s effort, parent—child discussion, and associations with positive peers, play a substantial role in increasing students' achievement. Bierman and Furman (1984) found that Peer Involvement increases peer acceptance and children's self-perceptions of their social efficacy. Valdebenito et al. (2012) reported that the peer learning is effective measure to improve reading comprehension skills. Kunsch, Jitendra and Sood (2007) reports that the success of peer relation is realized when students working in pairs help one another, learn material or practice an academic task. Thus, peer involvement works best when students of different ability levels work together. This practice gives students the opportunity to better understand the material being studied. It also reported that while low-achieving students may receive moderate benefits from peer involvement, effects for students, specifically identified with Learning Disability may be less noticeable unless care is taken to pair these students with a more proficient peer who can model and guide learning objectives. Apthorp et al. (2002) reports that a variety of peer-support programs are effective in teaching mathematics, including Class Wide Peer Tutoring (CWPT), Peer-Assisted Learning Strategies (PALS), and

Reciprocal Peer Tutoring (RPT). Successful peer-supporting approaches may involve the use of different materials, reward systems, and reinforcement procedures (Barley et al., 2002).

Dyscalculia has also been identified in relation to school failure and school dropout (Fernandez et al.,1989) and substance abuse (Hawkins, Catalano and Miller, 1992). For these outcomes, different factors come into play. Most children experience disturbed peer relationships; lack of parenting skills. Children who are unaccepted by their peers may be deprived of number of important exercises provided through positive peer contact. Falchikov (2007) reminds us that peer learning builds on a process that is part of our development from the earliest years of life. Spiller (2012) mentioned peer feedback can encourage collaborative learning through interchange about what constitutes good work. Students receiving feedback from their peers can get a wider range of ideas about their work to promote development and improvement. Peer evaluation helps to lessen the power imbalance between teachers and students and can enhance the students' status in the learning process. Tope (2011) mentioned that peer group could either positively or negatively influence the academic performance of in-school students.

Peer interactions play a significant and unique role in facilitating the development of appropriate assertiveness, altruistic behavior, moral reasoning and other social competencies involving reciprocal give and take relationships (Hartup, 1978). Moreover continued isolation from positive peer contact has been linked with a number of serious adjustment problems in later adolescence and adulthood (Cowen et al.,1973). Dame (2012) examines the differences between spacing of instruction and the classroom involvement of a cross-ability peer tutor on mathematical achievement in a developmental mathematics course. Dekovic(2002) mentioned that Peer relations bear stronger associations with developmental expectations and well-being in Japanese than in Dutch students. Thus, Peer-based work facilitates social norms, not only individual behavior, provides the opportunity for early intervention community effective and cost effective, helps in providing direction and guidance for the development of individuals. These unique characteristics explain why peer-involvement is so widely used and successful.

5.0.0 EMERGENCE AND JUSTIFICATION OF THE PROBLEM

Shalev(2004) cites that arithmetic is of prime importance in everyday life, enabling us to comprehend number concepts and perform calculations. Budgeting our time and monetary resources, reading calendars, locating an address and even following a recipe are examples of our dependence on elementary arithmetic skills. Yet the study of the various aspects of the normal and abnormal development of arithmetic has not received the same attention as have other learning disabilities. Mazzocco and Myers (2003) quoted that till date, research on math disability (MD) is

far less extensive than research on reading disability (RD). A search of articles published between 1974 and early 2003 yielded 14 to 33 times as many citations for "dyslexia" versus "dyscalculia". "Reading disability" was listed as a *Psychlnfo* key word, whereas no key word category existed for mathematical disability. Indeed, there were more citations for reading *disability* (2,415) than there were for math *ability* (2,154). Yet, like Reading Disability, Mathematical Disability is a significant obstacle to academic achievement for children. There is a need to better understand its causes and manifestation.

The researcher has made a systematic attempt to survey the researches on Dyscalculia and its co-morbidity with other learning disabilities in Indian and International context in order to carve out the precise skeleton of the research dimensions for the present study. It is critically analyzed that a few research studies have direct bearing upon the Dyscalculic Co-morbidity of students while some studies have tangential importance for the present problem. The researcher has summarized the important studies in tabular form, on the following page to support the selection of problem in this field proving its novelty, innovativeness and accessibility of available tools and techniques etc. fulfilling the desired parameters for justifying the research problem in hand.

Table 1.2 Exhibiting Domain Wise Selected Analysis of the Selected Studies at International and National Perspective

S.N.	RESEARCH VARIABLES	RESEARCHER	MAJOR FINDINGS
1.	Dyscalculic Co-morbidity	• Desoete, (2009) Stock &Roeyers, (2006) • Martinez & Semrud-Clikeman, (2004) • Bhargava et al., (2013)	• Examine the co-morbidity of clinical disorders in mathematical disability. • Mathematical disability in elementary school children was reported with different levels of intelligence. • Students with Mathematical and Reading Disability had more problems at schools and were often depressive than those without learning disabilities.
2.	Environmental Deprivation	• Pandit, (2004) • Shalev& Aster, (2008), Gross-Tsur, (2000)	• Factors related to children with learning disabilities in mathematics were the poor instruction, parents' adverse behavior, teacher's negligence in the class. • Common conditions causing Dyscalculia include over-crowded classroom, inadequate teaching methods, emotional issues and family adversity.
3.	Self-Esteem	• Grantham & Ford, (2003) • Aoife, (2011) Schaalma et al., (2004)	• Poor achievement of gifted African-American students can be largely attributed to poor self-esteem, low academic self-concepts and low social self-concepts. • Dyscalculia children who have learning disabilities are at risk for having lower self-esteem and self-worth than that of their peers.
4.	Peer- Involvement	• Emmanuel & Elizabeth, (2011) • Kunsch, Jitendra & Sood, (2007)	• Peer involvement has significant relationship with the problem of dyscalculia among students' with learning disabilities. • Low achieving students may receive moderate benefits from peer involvement.

From the above -mentioned list of studies referred by the researcher, it is worth noted that studies of Dyscalculic Co-morbidity primarily involve estimation of prevalence rate. Factors responsible for Dyscalculia are mainly focused in many studies but predictors of Dyscalculic Co-morbidity have not been studied at large extent. Researches conducted on Environmental Deprivation also summarized various factors responsible for mathematical disabilities with no discussion of co-morbid Dyscalculia. Importance of self-esteem for academic achievement can be clearly interpreted from above table. Studies on importance of self esteem for Dyscalculic students at national level are negligible which attract the attention of researcher for undertaking it in present study. It is also evident form critical review of the studies that only few studies have been carried out on peer-involvement with reference to Dyscalculic students. Besides it, the field remained untouched and opening new vistas for the researcher.

Dowker (2005) quoted that problems with learning disabilities are life-affecting and that the impact of poor mathematical skills on employment prospects is even bigger than the influence of poor reading skills. Children with the mathematical disabilities are vulnerable to multiple risks, including persistence of the learning handicap, school drop out, and emotional instability. Therefore, treatment of dyscalculic co-morbidity should address the multiple facets of the disorder while focusing on educational interventions to improve study skills in general and strengthening number perception and arithmetic concepts in particular.

6.0.0 STATEMENT OF THE PROBLEM

In context with the above justification, the present problem can be stated as:

Dyscalculic Co-morbidity in Secondary School going Children- A Comprehensive study of Predicting Parameters and Remedies.

7.0.0 OPERATIONAL DEFINITIONS OF THE TERMS

The above stated research problem consists of the following terms which require explanation in order to clarify the exact meaning with respect to present study. The terms which need detailed contextual definitions are as following:

7.1.0 DYSCALCULIC CO-MORBIDITY

Gersten et al. (2005) define Dyscalculia as: "Dyscalculia refers to a persistent difficulty in the learning or understanding of number concepts, counting principles or arithmetic. These difficulties are often called Mathematical Disability." Elsevier (2009) defines Co-morbidity as two or more coexisting medical conditions or disease processes that are additional to an initial diagnosis.

In the present study, Dyscalculia is considered as mathematical disability caused by genetic or environmental factors. It can be quantitative, which is a deficit in counting and calculating and

qualitative, which is a difficulty in the conceptualizing of math processes. It is characterized by the problem in understanding basic mathematical principles and operations, problem in dealing with time, difficulty in sequencing events, putting language to math processes, poor mental arithmetic skills, inconsistent computation results in mathematical operations, problem in dealing with money and cash transactions, irrespective of the age and intelligence of individual.

In present context of the study, Co-morbidity is considered as co-occurrence of one or more disorders in an individual. Dyscalculia is a typical kind of Learning Disability which is not usually reported in isolation by the researchers. Generally there is a co-occurrence of number of other related problems (Dyslexia) fused with Dyscalculia which in combined form notified as Dyscalculic Co-morbidity.

7.3.0 ENVIRONMENTAL DEPRIVATION

In present study Environmental Deprivation is considered as lack of appropriate conditions in living Environment including Family (Family Adversity, Parental inattention and expectations, Socio-Economic status of family, Differential treatment towards girls),School(Poor teaching skills, Inadequate instruction, Overcrowded classrooms, Curriculum inefficacy) and Society (Location of home, deprived areas, school location) to stimulate intellect and behavioral growth of students. Inappropriate instructions, over-crowded classrooms, untested curricula, parental attitude and support etc form various dimensions of environmental deprivation.

7.4.0 SELF-ESTEEM

Cherry, (2010) defined Self-esteem as: "Self-esteem is used to describe a person's overall sense of self-worth or personal value. Self-esteem is often seen as a personality trait, which means that it tends to be stable and enduring. Self-esteem can involve a variety of beliefs about the self, such as the appraisal of one's own appearance, beliefs, emotions and behaviours."

In present study, Self-esteem refers to the evaluation which the individual makes and customarily maintains with regard to himself. It expresses an attitude of approval or disapproval, and indicates the extent to which the individual believes himself to be capable, significant, successful, and worthy.

7.5.0 PEER INVOLVEMENT

Peer group may be defined as a group of people who, through homophily share similarities such as age, background, and social status. The members of this group are likely to influence the person's beliefs and behavior.

In present study, Peer Involvement is the extent of support, feedback, acceptance and appraisal which a person can have from his peer group in context of his strengths and weaknesses. Peer involvement

in present context is guidance and support, peer attitude and disposition towards mathematical learning disabled students.

8.0.0 OBJECTIVES OF THE STUDY

The aim of the research is to study that how Dyscalculic Co-morbidity is affected by Environmental Deprivation, Self-esteem and Peer Involvement of students. In order to achieve this aim, the researcher has laid down the following objectives:

1. To study the independent effect of predictive variables viz. *Environmental Deprivation, Self-esteem and Peer-Involvement* on Dyscalculic Co-morbid students.
2. To examine the interactional effect of Environmental Deprivation and Self-esteem on Dyscalculic Co-morbid students.
3. To examine the interactional effect of Environmental Deprivation and Peer Involvement on Dyscalculic Co-morbid students.
4. To examine the joint influence of Environmental Deprivation, Self-Esteem and Peer-Involvement on Dyscalculic Co-morbid students.
5. To compare the independent effect of predictive variables viz. *Environmental Deprivation, Self-esteem and Peer involvement* on Dyscalculic Co-morbid male and female students.
6. To compare the joint influence of Environmental Deprivation, Self-esteem and Peer-Involvement on Dyscalculic Co-morbid male and female.
7. To suggest some remedial intervention program for Dyscalculic co-morbid students.

9.0.0 HYPOTHESES OF THE STUDY

In order to achieve the above-mentioned objectives the researcher has formulated the following hypotheses :

1. There exists no significant effect of predictive variables Environmental Deprivation, Self-esteem and Peer-Involvement on Dyscalculic Co-morbid students when treated independently.
2. There exists no significant interactional effect of Environmental Deprivation and Self-esteem on Dyscalculic Co-morbid students.
3. There exists no significant interactional effect of Environmental Deprivation and Peer Involvement on Dyscalculic Co-morbid students.
4. There exists no significant interactional effect of all predictive variables on Dyscalculic Co-morbid students.
5. There exists no significant difference in effect of predictive variables on Dyscalculic Co-morbid male and female students when treated independently.
6. There exists no significant difference in effect of predictive variables on Dyscalculic Co-morbid male and female students when treated jointly.

10.0.0 VARIABLES IN THE STUDY

The operational variables of the present study are as follows:

1. *Criterion Variable:* Dyscalculic Co-morbidity.
2. *Predictive Variable*: Environmental Deprivation Self- esteem & Peer- Involvement.
3. *Control Variable:* Age, Grade, Subject, Teacher.

11.0.0 DESIGN OF THE STUDY

The researcher has planned well to make out the study. The sample selection, methodology, tools and techniques to be used and statistical techniques to be employed during the research work have been laid down as following:

11.1.0. METHOD OF THE STUDY

The researcher will employ Descriptive Survey Method in order to identify the Dyscalculic Co-morbidity and determinants in students in present context.

11.2.0. SAMPLE OF THE STUDY

The sample selection in the present study will be done in two distinct stages as given below:

STAGE I: SAMPLING OF SCHOOLS

The researcher will use simple random method of sampling for the selection of schools in the present study from Agra city. The researcher will select private English medium schools affiliated to CBSE and ICSE Boards of Examinations, Delhi. The medium of instruction is specifically considered here as the tools employed in the present study are in English language.

STAGE II: SELECTION OF DYSCALCULIC CO-MORBID STUDENTS

In this stage of sampling, researcher will select 100 boys and 100 girls of VII and VIII standards, aged between 12-13 years through simple random sampling method from English medium schools of Agra City.

11.3.0. TOOLS AND TECHNIQUES TO BE EMPLOYED IN THE STUDY

In order to collect relevant data for the fulfilment of the proposed objectives, the following tools will be employed by the researcher.

11.3.1 For the Identification of Dyscalculic Co-morbidity in Students

With best of the researcher's knowledge and exploration, there is no tool available for identifying the Dyscalculic Co-morbidity in students, therefore a self-constructed tool for identifying Dyscalculic Co-morbidity students of class VII and VIII will be used.

11.3.2 For Measuring the Predictive Variables

1. Environmental Deprivation: Environmental Deprivation will be explored at family and school level. Separate tools will be used for both levels.

(a) For School Environment Deprivation, *Classroom Environment Scale(CES, 1996), by EJ Trickett* will be used after adaptation. It evaluates the effects of course content, teaching methods, teacher personality, class composition and characteristics of the overall classroom environment. It contains 90 items, organized into nine subscales in three dimensions, (i)*Relationship Dimension(Involvement, Affiliation, Teacher Support),(ii)Goal Orientation Dimension(Task Orientation, Competition) and (iii)Change Dimension(Order and Organization, Rule Clarity, Teacher Control, Innovation).*

(b) For Family Environment Deprivation, *Family Environment Scale(FES, 1994) by R.H. Moss and B.S. Moss* will be used after adaptation. It is a 90 item inventory that has 10 subscales viz. (i) *Measurement of Cohesion, (ii) Expressiveness, (iii) Conflict,(iv)Independence,(v)Achievement orientation,(vi)Intellectual-cultural orientation,(vii) Active-recreational orientation, (viii) Moral-religious emphasis,(ix) Organization and (x) Control.*

2. Self-esteem: For measuring Self-esteem of Dyscalculic Co-morbid students, *Coopersmith Self-Esteem Inventory (1967) by S. Coopersmith* will be used. It is 50-items inventory designed for measuring children's self-esteem.

3. Peer-Involvement: For measuring Peer-involvement of Dyscalculic Co-morbid students, *self constructed tool* will be employed.

11.4.0. STATISTICAL TECHNIQUES TO BE EMPLOYED

The following statistical techniques will be employed for the analysis of data:

1. *One-way ANOVA* will be employed for studying the independent effect of three predictive variables (*Environmental Deprivation, Self-Esteem and Peer-Involvement*) of Dyscalculic Co-morbid students.
2. *Two-way ANOVA* will be employed for studying the interactional effect of first and second set of two predictive variables on the criterion variable of Dyscalculic Co-morbid students.
3. *Multiple ANOVA* will be employed for studying the interactional effect of all three predictive variables on the criterion variable of Dyscalculic Co-morbid students.
4. *Regression Analysis* will be employed for predicting the effect of predictive variables on criterion variable.
5. *t-test* will be employed to compare the independent effect of three predictive variables (Environmental Deprivation, Self-esteem and Peer Involvement) on male and female Dyscalculic Co-morbid students.

11.5.0 DELIMITATIONS OF THE STUDY

The present study will be conducted assuming the following delimitations:

1. The present study will be delimited to English medium schools of Agra city, affiliated to CBSE and ISCE boards, Delhi.
2. The study will be delimited to girls and boys both studying in class VII and VIII.

12.0.0 SIGNIFICANCE OF THE PROBLEM

It is hard not to overemphasize the importance of mathematical literacy in our society (Swanson, Jerman, & Zheng, 2008). In everyday life situations we need to solve everyday problems that include a set of rules and algorithms, be in time, pay bills, follow directions or use maps, look at bus or train timetables or comprehend instruction leaflets and expiry dates. A lack of mathematical literacy was found to affect people's ability to gain full-time employment and often restricted employment options to manual and often low paying jobs (Desoete, 2007; Dowker, 2005). Shaikh (2013) quoted there is a common perception that mathematics is a very difficult subject. As much as possible students tend to avoid taking math courses. Avoiding math courses severely restricts the fields a student can study and the jobs one can find. Now a days however, many have realized the importance of Mathematics, not only from the point of view of getting an academic qualification at school or college, but is also a subject that prepares one for the future as well, irrespective of which walk of life one chooses to be a part of. Today youth are faced with many challenges, including changing family constellations, negative peer influence, economic hardship, untested curricula, inadequate family and school environment and exposure to violence, availability of drugs and alcohol, development of low self-esteem and a general lose of community bonds. Long term exposure to these risky conditions may have debilitating consequences, particularly if one must deal with them in addition to a learning disability and could have some negative impact not only on the well-being of these students, but also on significant others and society as it causes behavioral problems in students and frustration in other concern individuals.

Thus, it is the need of the hour that young children build confidence in their ability to do mathematics in today's high-tech, increasingly connected world, as deficiencies in this area can be a major impediment to many facets of life. These students may need extra assistance through hands-on manipulative and pictorial representations of mathematical concepts so that they can understand numerical symbols and abstract equations at a concrete level. This study will provide effective measures to overcome the problem of Dyscalculic co-morbid students so that they can also match their feet in today's challenging world by cutting out the roots of very basic disability i.e. mathematical disability.

REFERENCES

Aoife, L. (2011). Self-Esteem and Learning Disabilities. Retrieved from http://www.ldail.org/esteem.cfm.

Arcelus, J., & Vostanis, P. (2005). Psychiatric co-morbidity in children and adolescents. *Current opening in Psychiatry, 18,* 429-434.

Badian, N.A. (1983). Dyscalculia and Nonverbal Disorders of learning in Myklebust, H.R.(Ed). *Progress in learning disabilities, New York, 5.*

Behrad, B. (2006). Prevalence of learning disabilities in Iranian primary students :a meta-analysis. *Journal of Research on Exceptional Children, 4,* 417-436.

Beygi, A., Padakannaya, P., & Gowramma, I.P. (2010). A Remedial Intervention for Addition and Subtraction in Children with Dyscalculia. *Journal of Indian Academy of Applied Psychology, 36*(1).

Brunda, A., & Bhavithra, J. (2010). Adaptive computer assisted instructions(CAI) for students with Dyscalculia. Retrieved from http://dl.acm.org/citation.cfm?id=1858378.185.8390 doi: 101145/1858378.1858390.

Butterworth, B. (2010). Foundational Numerical Capacities and the Origins of Dyscalculia. *Trends in Cognitive Sciences. 14*(12): 534-541. Doi:10.1016/j.tics.2010.09.07.PMID 20971676.

Chavan, S. Bir, Bhargava, R., & Sharma, A. (2013). Prevalence of Specific Developmental Disorder of Scholastic Skill in School Students in Chandigarh, India. *Indian Journal Medical Res., 138,* 89-98.

Cherry, (2010). What is self-esteem? Retrieved from http://psychology.about.com/od/sindex/f/what-is-self-esteem.htm.

Chiu, L.H. (1990). The relationship of career goal and self-esteem among adolescents. *Adolescence, 25,* 593-597.

Clark, Watson, D., & Reynolds, S. (1995). Diagnosis and classification of psychopathology: challenges to the current system and future directions. *Annual Review of Psychology, 46,* 121-153.

Dekovic, M., & Meeus, W. (1997). Peer relations in adolescence: Effects of parenting and adolescents; self concept. *Journal of Adolescence, 20,* 163-176.

Desforges, (2003). The impact of parental involvement, parental support and family education on Pupil achievement and adjustment: A literature review. Department for Education and Skills, ISBN 1 84185 999 0

Desoete, A. (2008). Co-morbidity in Mathematical Learning Disabilities: Rule or Exception? *The Open Rehabilitation Journal, 1.*

Desoete, A. (2009). Mathematics and Metacognition in Adolescents and Adults with Learning Disabilities. *International Electronic Journal of Elementary Education, 2*(1).

Desoete, A.,Roeyers, H., & DeClecq, A. (2004). Children with Mathematics Learning Disabilities in Belgium. *Journal of Learning Disabilities, 37,* 50-61.

Dowker, A. (2004). What works for children with mathematics difficulty? (RR554), DfES, London.

Dyslexia Blog:Sharing resources and information about Dyslexia for Parents-Dyscalculia day 3rd march, Retrieved from http://dyslexiaparents.blogspot.in/2010/03/dyscalculia-3rd-march.html.

Elliot, S. (2008). The Effect of Teachers' Attitude towards Inclusion on the practice and success levels of children with and without disabilities in Physical education. *International Journal of Special Education , 23*(3*).*

Elsevier, (2009). Co-morbidity, Mosby's Medical Dictionary, 8th edition. Retrieved from http://medical-dictionary.thefreedictionary.com/comorbidity

Emmanuel, O., & Elizabeth, A. (2011). Family Factors, Self-Esteem and Peer-Involvement as predictors of Dyscalculia among students with Learning Disabilities in Ikeja, Lagos State of Nigeria. *Journal of Research in Education and Society, 2*(1).

Fletcher, J.M. & Loveland, K. A. (1986). Neuropsychology of arithmetic disabilities in children. *Focus on learning problems in mathematics, 87,* 23-40.

Forrest, B. (2004). The utility of math difficulties, internalized psychopathology and visuo-spatial deficits to identify children with the non verbal learning disability syndrome: Evidence for a visual spatial Disability. *Mild Neuropsychology, 10,* 129-146.

Fuchs, S. Lynn, & Fuchs, D. (2002). Mathematical Problem-Solving Profiles of Students with Mathematics Disabilities with and without Co-morbid Reading Disabilities. *Journal of Learning Disabilities, 35*(6).

Geary, D. C., Bailey, D. H., & Hoard , M.K. (2009). Predicting Mathematical Achievement and Mathematical Learning Disability with a Simple Screening Tool: The Number Sets Test. *Journal of Psychoeduc Assess, 27*(3): 265–279, doi:10.1177/0734282908330592.

Geary, D.C. (2004). Mathematics and Learning Disabilities. *Journal of Learning Disabilities, 37*(1), 4-13.

Geary, C. David, Bailey, H. Drew. (2009). First-Grade Predictors of Mathematical Learning Disability: A latent Class Trajectory Analysis. doi:10.1016/j.cogdev.2009.10.001.

Gersten, R., Jordan, N.C., & Flojo, J.R. (2005). Early Identification and Interventions for Students with Mathematics Difficulties. *Journal of Learning Disabilities, 38*(4), 293-304.

Gifford, S. (2005). Dyscalculia: Issues of Existence, Identification and Prevention. *Proceedings of British Society for Research into Learning Mathematics,25*(3).

Griffin, S., & Case, R. (1997). Wrapping up: using peer commentaries to enhance models of mathematics teaching and learning. *Issues In Education, 3,* 115-134.

Gross-Tsur, V., Manor, O., & Shalev, R.S. (1996) Developmental Dyscalculia: Prevalence and Demographic Features. *Developmental Medicine and Child Neurology, 38,* 25-33.

Guillemot, Teresa. (2001). Dyscalculia-An Overview of Research on Learning Disability.

Hall, W., Lynskey, M., & Teesson, M. (2001). What is comorbidity and why does it matter? In M. Teesson & L. Burns (Eds.), National Drug Strategy: National Comorbidity Project (pp 11-12). National Drug and Alcohol Research Center, University of NSW: Sydney.

Hamid, S., Hayati, M., Matzin, R., Mahallen, S., Mundia, L., & Hassanal, S.(2013). Barriers to Mathematics Achievement in Brunei Secondary School Students: Insights into the Roles of Mathematics Anxiety, Self-Esteem. Published by Canadian Center of Science and Education *International Education Studies, 6*(11*),* ISSN 1913-9020, E-ISSN 1913-9039

Hanich, L.B., Jordan, N.C., Kalpana, D., & Dick, J. (2001). Performance across different areas of mathematical cognition in children with learning difficulties. *Journal of Educational Psychology, 93,* 615-626.

Hoge, D.R, Smit, E.K., & Hason, S.L. (1990). School experiences predicting changes in self esteem of sixth and seventh grade students. *Journal of Educational Research,* 82(1), 117-127.

Janos, P.M., Fung, H.C., & Robinson, N.M. (1985). Self-concept, Self Esteem, and peer relations among gifted children who feel different. *Gifted Child Quaterly, 29,* 78-82.

Jayaram, M.A., & Shilpa, B. (2010). Intelligent System for Diagnosing Learning Disorders in Children. *Proceedings of the World Congress on Engineering and Computer Science, 1.*

Jordan, N.C., Hanich, L.B., & Kaplan, D. (2003). Arithmetic fact mastery in young children: A longitudinal investigation. *Journal of Experimental Child Psychology, 85,* 103-119.

Jovanovic, G., Jovanovic, Z., Bankovic, J., Nikolic, A., Svetozarevic, S., & Ignjatovic, D. (2013). The Frequency of Dyscalculia among Primary School Children. *Psychiatria Danubina, 25*(2), 170-174.

Karatas, I., & Baki, A. (2013).The Effect of Learning Environments Based on Problem Solving on Students' Achievements of Problem Solving. *International Electronic Journal of Elementary Education, 5(*3), 249-268.

Kaslow, F.W., & Cooper, B. (1978). Family Therapy with the learning disabled child and his/herfamily. *Journal of Marriage and Family Counselling, 4,* 41-49.

Kaufmann, L., & Aster, V. Michael. (2012). The Diagnosis and Management of Dyscalculia. *Dtsch Arztebl International, 109*(45), doi:10.3238/arztebl.2012.0767.

Khokhar, C.P., & Upadhayay, B. (2007). Poor physical environment & Adjustment of adolescents. *Europe's Journal of Psychology, 3*(3).Reterieved from http://ejop.psychopen.eu/article/view/407

Kibby, M. Y., Marks, W., Morgan, S., & Long, C.J. (2004). Specific Impairment in developmental reading disabilities: A working memory approach. *Journal of Learning Disabilities, 37*(4), 349-363.

Kosc, L. (1974). Developmental Dyscalculia. *Journal of Learning Disabilities, 7,* 164- 177.

Koumoula, A., Tsironi, V., Stamouli, V., Bardani, I., Siapati, S., & Graham, A. (2004). An epidemiological Study of number processing and mental calculation in Greek School children. *Journal of Learning Disability, 37,* 377-388.

Kunsch, C., Jitendra, A., & Sood, S. (2007). The effects of peer mediated instruction in mathematics for students with learning problems: A research synthesis. *Learning Disabilities Research and Practice, 22*(1), 1-12.

Lewis, C., Hitch, G.J., & Walker, P. (1994). The prevalence of specific arithmetic difficulties and specific reading difficulties in 9-year old to 10-year-old boys and girls. *Journal of Child Psychology and Psychiatry, 35,* 283-292.

Light, J.G., & DeFries, J.C. (1995). Co-morbidity of reading and mathematics disabilities: Genetic and Environmental Etiologies. *Journal of Learning Disabilities, 28,* 96-106.

Lindsay, L. Ronald, Tomazic, T., & Levine, D. M. (1999). Impact of Attentional Dysfunction in Dyscalculia. *Developmental Medicine & Child Neurology, 41,*639-642.

Lovitt, T.C. (1978). Applied behavior analysis and learning disabilities-specific research recommendation and suggestions for practitioners. *Journal of Learning Disabilities, 8,* 504-518.

Mann, M., Hosman, C.M., Schaalma, H.P. & deVries, N.K. (2004). Self-esteem in a broad spectrum approach for mental health promotion. *Health Education research, 19,* 357-372.

Martinez, R. & Semrud-Clikeman, M. (2004). Emotional Adjustment and school functioning of young adolescents with multiple versus single learning disabilities, *Journal of Learning Disabilities, 37i(5), 411-420.*

Mazzocco, M. M., & Myers, G.F. (2003). Complexities in identifying and defining mathematics learning disability in the primary school age years. *Annuals of Dyslexia, 53,* 218-253.

Miller, S.P., & Mercer, C.D. (1997). Educational Aspects of Mathematical Disabilities. *Journal of Learning Disabilities, 30,* 47-56.

Mogasale, V.V., Patil, V.D., Patil, N.M.,& Mogasale V.(2012). Prevalence of specific learning disabilities among primary school children in a South Indian city. *Indian Journal of Pediatrics, 79*(3), 342-347, doi: 10.1007/s12098-011-0553-3

Monuteaux, C., Faraone, V., Herzig, K., Navsaria, N., & Biederman, J. (2005). ADHD and Dyscalculia:Evidence for Independent familial Transmission. *Journal of Learning Disabilities, 38*(1), 86-93.

Mundia, L. (2012). The Assessment of Math Learning Difficulties in a Primary Grade-4 Child with High Support Needs: Mixed Methods Approach. *International Electronic Journal of Elementary Education, 24(2), 347-366.*

Munro, J. (2003). Dyscalculia: A Unifying Concept in Understanding Mathematics Learning Disabilities. *Australian Journal of Learning Disabilities, 8*(4).

Neale, M.C. & Kendler, K.S. (1995). Models of co-morbidity for multifactorial disorders, *American Journal of Human Genetics, 57(4), 935-953.*

Olden, K., & Guthrie, J. (2001). Environmental Influences on Learning Disabilities. *Learning Disabilities Journal, 11*(1).

Ostad, S. A. (1998). Developmental differences in solving simple arithmetic word problems and simple number fact problems: A comparison of mathematically disabled children. *Mathematical Cognition, 4,* 1-19.

Ozsoy, G., & Ataman, A. (2009).The effect of metacognitive strategy training on mathematical problem solving achievement. *International Electronic Journal of Elementary Education 1*(2).

Pandit, P. (2004). Factors Affecting Learning Disabilities in Mathematics: A Study of Central Region of Nepal. *Tribhuvan University Journal,24*(1).

Pennigton, B.F. (2006). From single to multiple deficit models of developmental disorders. *Cognition, 101,* 385-413.

Price, G.R., & Ansari, D. (2013). Dyscalculia: Characteristics, Causes, and treatment. Numercacy, *Advancing Education in Quantitative Literacy*, *6*(1), DOI: http://dx.doi.org/10.5038/1936-4660.6.1.2 retrieved from http://scholarcommons.usf.edu/numeracy/vol6/iss1/art2

Ramaa, S., & Gowramma, I.P. (2002). A systematic procedure for identifying and classifying children with Dyscalculia among primary school children in India. Published online in Wiley Interscience (www.interscience.wiley.com), doi:10.10021dys.214, *Dyslexia, 8*, 67-85.

Rejno- Habte, Selassie, G., Jennische, M., Kyllerman, M., Viggedal, G., & Hartelius, L. (2005). Comorbidity in severe developmental language disorder: Neuropediatric and psychological considerations. Acta paediatrica, 94, 471-478.

Rhee, S.H., Hewitt, J.K., Corley, R.P., Wilcut, E.G., & Pennigton, B.F. (2005). Testing Hyptothesis regarding the causes of comorbidity : Examining the underlying deficits of comorbid disorders. *Journal of Abnormal Psychology, 114,* 346-362.

Rubinsten, O., & Tannock, R. (2010). Mathematics Anxiety in Children with Developmental Dyscalculia. Retrieved from http://www.behavioralandbrainfunctions.com/content/6/1/46

Rubinsten, O., & Henik, A. (2009). Developmental Dyscalculia: Heterogeneity might not mean Different Mechanisms. *Trends Cognition Science.,13*(2), 92-99, doi:10.1016/j.tics.2008.11.002.

Scott, G. Cynthia. (1996). Student Self-Esteem and the School System: Perceptions and Implications. *The Journal of Educational Research,89*(5).

Scheiris, J., & Desoete, A. (2008). The prevalence of some specific developmental and behavioral disorders and their co-morbidity, Signaal, *62*,4-14.

Shaikh, S.N. (2013). Mathematics Anxiety Factors and their Influence on Performance in Mathematics in Selected International Schools in Bangkok. *Journal of Education and Vocational Research , 4* (3), 77-85.

Shalev, S. R. (2004). Developmental Dyscalculia. *Journal of Child Neurology, 19*(10).

Shalev, S. Ruth, Aster, G. Von Michael. (2008). Identification, Classification and Prevalence of developmental Dyscalculia

Tajar, J., & Sharifi, S. (2011). Dyscalculia: Learning Disabilities in Mathematics and Treatment with Teaching Remedial method Iranian children 6 Years Old. *Australian Journal of Basic and Applied Sciences, 5*(9).

Temple, C.M., & Sherwood, S.(2002). Representation and Retrieval of arithmetical facts: Developmental Difficulties. *QJ Exp Psyhology, 55,* 733-752.

Tope, (2011). The influence of peer group on adolescents' Academic performance: a case study of some Selected schools in ogun state, retereived from www.omoteretope.com, eBook Identification No: 20110122

Valdebenito, V., Blanch, S.,Duran, D., & Flores, M. (2011). The effects and characteristics of family involvement on a peer tutoring programme to improve the reading comprehension competence. *Journal of Psychology Education,* DOI 10.1007/s10212-012-0104-y

Van der Sluis, S., de Jong, P.F., & Van der leji, A. (2007). Executive functioning in children, and its relations with reasoning, reading and arithmetic. *Intelligence, 35,* 427-449.

Vijayalaxmi (2009). The Prevalence Of Specific Learning Disabilities Among Primary School Children Of Belgaum City: A Cross Sectional Study, retrieved from http://hdl.handle.net/123456789/636

Wang, G., Du, H. & Liu, Y. (2009). Case Study on Improving High School Students with Learning Difficulties in Mathematics. *Journal of Mathematics Education* , 2(2), 122-133.

Wehmeyer, M.L. (1996). Self-determination as an educational outcome: Why is it important to children, youth and adults with disabilities? In D.J. Sands & Wehmeyer (Eds.), Self determination across the life span: Independence and choice for people with disabilities, (pp. 15-34). Baltimore: Paul, H. Brookes.

Wilson, A.J., Revkin, S.K., Cohen, L., Cohen, S., & Dehaene. (2006). An open trial assessment of the number Race, an adaptive computer game for remediation of dyscalculia. Doi: 10.1186/1744-9081-2-20.Retrieved from http://www.behavioralandbrainfunctions.com.content/2/20

Woolfolk, A.E. (2005). *Educational Psychology* (9th Ed.). Bosten: Alleyn & Bacon.

Zainab, P., & Sasikumar, M. (2013). Accomodation for Dyscalculic Children in an E-Learning Environment. *International Journal of Computer Applications,70*(2).